Vibratory analysis of elements of the suspension and steering system of an all-terrain car

Advanced manufacturing processes and materials

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Abstract

The suspension and steering system play an important role in vehicles because the suspension system is responsible for ensuring good stability in curves, maximum driving comfort and maneuverability of a vehicle and the steering system has the function of allowing the driver has control of the vehicle's trajectory in an easy way, these systems are made up of a set of elements, for this work some of these elements will be considered, such as the forks and masses. This is because this all-terrain vehicle prototype is still in the construction and design phase.

The objective of this proposal is to carry out a vibrational analysis in the steering system of an all-terrain car starting from the modeling of a steering system with the purpose of analyzing it in the SolidWorks software and determining the vibrational behavior of each element and detecting potential modes of vibration. fails considering the conditions to which it will be exposed in the competitions. For this proposal, a simulation will be carried out, since today there are different effects which are reflected and perceived by the driver. Therefore, the purpose is to make the vehicle safer, complying with active safety actions.

Finally, the results obtained by the frequency studies will be announced and an interpretation will be given with the purpose of establishing future objectives that allow us to continue improving this proposal.

Introduction

The following work will present the development of a vibration analysis on the suspension and steering system. It is a failure and accident prevention system. Therefore, the calculations and simulations were carried out to observe its operation. Suspension and steering parts made by SolidWorks software will be implemented, this to perform an assembly and carry out simulations to detect failures and defects within each component.

The sections that will be released in this project are the following:

- Modeling.
- Assembly.
- Frequency analysis of vehicle steering and suspension elements.
- Design of steering system.

Objective: Carry out an analysis where the vibratory effects and movements that occur in the vehicle in the suspension and steering part are reflected to provide greater safety, smoothness, precision and stability to the driver when driving. To carry out this project, several studies were carried out in different parts of the proposed suspension in order to improve them and make them of maximum safety for the vehicle.

Figure 1

Materials and methods

Frequency Study: Frequency analysis calculates natural frequencies and associated mode shapes.

Frequency: It is the measure of the number of times a phenomenon is repeated per unit of time.

Natural frequencies: The natural frequency is the frequency at which an object will continue to vibrate after hitting it.

Mechanical vibrations: These are movements that are repeated after an interval of time.

Results

The models of the elements that make up the steering system with which we are working were developed and the frequency analyzes of the proposed parts for the implementation of the suspension and steering system were obtained, to observe if there were faults and defects within each component.

This is the element that has the highest frequency range, so we consider this element to be in a range from 7 kHz to 15 kHz. As part of our future objectives, it is to do more tests with the car and all its included systems. and verify that it is within really acceptable ranges.
However, some elements we consider to be in low ranges and considering the conditions of the terrain in which this type of vehicle competes, the elements most likely enter into resonance and end up failing.

Figure 2 Model

Modo nº.	Frecuencia(Hertz)	Dirección X	Dirección Y	Dirección Z
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]

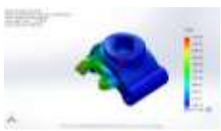
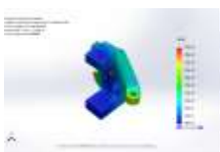


Figure 3 Rear Mass Analysis Result

Some elements are in average ranges, so if we require a higher range of frequencies, applying some modifications such as material or dimensions should be enough. If it is necessary to make any changes, the frequency studies will be reapplied in order to observe the change that they will suffer in case of making any modification.



Modo nº.	Frecuencia(Hertz)
1	1,458
2	2,489.6
3	3,602.7
4	3,892.9
5	4,594.3

Figure 4 Front Mass Analysis Result

This is the element that has the lowest frequency range, so in a real situation it is very easy for an external factor such as a bump or pothole to cause the fork of our steering system to resonate and therefore end up failing.

Modo nº.	Frecuencia (Hertz)	Dirección X	Dirección Y	Dirección Z
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]

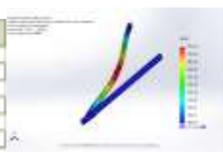


Figure 5 Fork Analysis Result

Conclusions

In conclusion, in carrying out this proposal, it was possible to carry out a vibrational steering analysis for the all-terrain car, which is one of the main objectives, in addition, the modeling of some elements of the steering system that is expected to be used in the future was achieved. once performing all the corresponding tests and applying the necessary adjustments. It was also possible to determine the frequency range in which the current design is found.

Obtaining this information is also part of the main objectives because a forecast of the current behavior can be obtained and the areas that are most likely to fail can be determined.

We detected some parts of the steering system that need to be redesigned because their frequency ranges are too low and we consider that in a real situation, these elements could go into resonance mode and fail in the middle of some competition.

Future of research

The objectives established for the future of this project are:
Make adjustments to the design based on the data obtained from the aforementioned simulations.
Carry out analyzes to determine other aspects, not only vibratory, but also the efforts to which said elements will be subjected.
Carry out experimental tests to determine the frequency ranges of soil irregularities.

Acknowledgments

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References

R. (2011b). Vibraciones Mecánicas (5.a ed.). Pearson Educación.

GOMEZ-MERCADO, Abdiel. (2017, diciembre). Análisis y simulación de frecuencia del sistema de suspensión McPherson para un vehículo automotor. (E. GUADARRAMA-MARTINEZ, Ed.). ECORFAN. https://www.ecorfan.org/spain/researchjournals/Ingenieria_Mecanica/vol1num4/ECORFAN_Revista_de_Ingenier%c3%ada_Mec%c3%a1nica_V1_N4_2.pdff

Mecánica, U. C. I. D. M. D. D. I. (2022, 10 mayo). Modelado y análisis vibratorio de un bogie 446 ante defecto de plano de rueda. Modelado y análisis vibratorio de un bogie 446 ante defecto de plano de rueda. http://hdl.handle.net/10016/34758

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